PIANO TUNERS MANUAL

HOW TO USE THE

Stroboconn

IN PIANO TUNING

CONN

Conn Corporation • Elkhart, Indiana

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Revised 1963

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INTRODUCTION

The Stroboconn is an electronic device for instantaneous and accurate visual measurement (or comparison) of sound frequencies. Its frequency range is from 31.772 to 4,066.8 cycles per second—essentially covering the range of the piano keyboard.

The Stroboconn is now widely known and is rapidly becoming a daily byword among piano tuners and technicians throughout the world. It is a highly scientific addition to the traditional "tools of the trade," which enables the tuner to carry on his skilled work more rapidly and with more confidence than ever before.

Here are some of the most practical and helpful ways in which the STROBOCONN *saves time* and *increases the earnings* of the tuner!

1. Time consuming and difficult "setting of temperament" is speeded up to require no more time than other octaves. Each note is tuned visually, quickly, and the temperament is automatically set.
2. Time required to "beat" (count beats) is eliminated—visual pattern appears immediately.
3. Time required for total tuning job may be greatly reduced with this advanced method.
4. A permanent, visual record of each tuning can be kept which enables an exact duplication of the tuning job at any time.
5. Piano can be tuned to standard of A-440—or any other standard of frequency, with equal ease.
6. Piano can be tuned with ease to mean-tone scale, Pythagorean Scale, Just Scale, or any other scale.
7. The amount of octave stretching required by each piano can be measured with the Stroboconn, enabling the technician to achieve the best sound the piano is capable of producing.
8. Enables the technician to use more of his perception powers by using both eyes and ears to give less chance for error and means for quick checks to see if any accidental change has occurred.
9. Many tuners are getting higher prices for Stroboconn tunings.
10. Although this is a simplification and extension of a technique already used by some technicians, it provides, for the first time, an accurate and dependable visual guide.
11. Proof of the accuracy of the tuning job can be given the customer by showing him the visual reading on the Stroboconn. This creates customer confidence and satisfaction.
12. Makes possible "identical" tunings for two or more pianos to be used together or for piano and organ.
13. Makes accurate tuning possible in noisy surroundings.

The information which follows will help clarify many questions which may occur to you in connection with the use of the Stroboconn in piano tuning! In addition, it is also urgently suggested that the operator's manual be studied carefully before using the instrument.

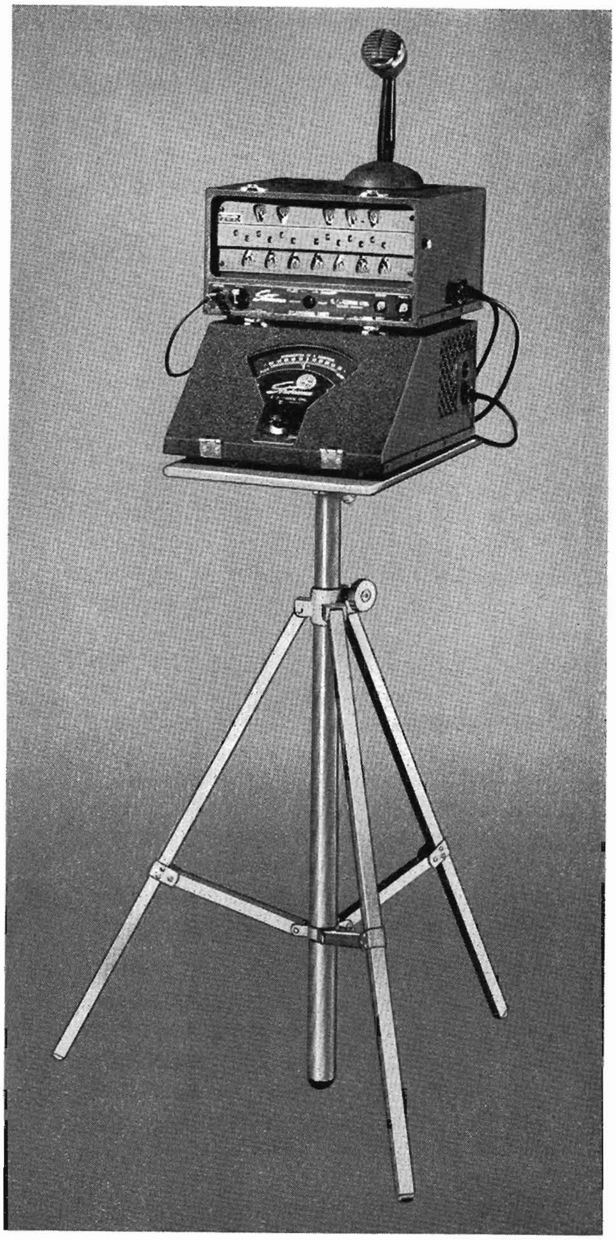


Figure 1—Pictured above is Model 6T-3 Stroboconn, complete with desk-type microphone, one encased Scanning Unit, one encased Tuning Unit, and necessary interconnecting electrical and a-c power cables.

SETTING UP THE STROBOCONN

Set up the two cases comprising the Stroboconn on their wide sides with handles to the right, unlatch covers and remove cables, microphone, and microphone stand from cover compartment. Arrange units and connect cables as shown in Figure 2. The two-prong plug goes to the power receptacle, and the three-prong cable connects the two units. After inserting the three-prong plugs on the interconnection cable, give each a firm twist clockwise to lock them in place. (It is impossible to insert the connectors improperly.) Assemble microphone stand, insert microphone plug into its input receptacle on the scanning unit, and turn the volume control to the right to MAXIMUM. (To save space, and gain height for easier reading, it is suggested that the Scanning Unit be placed on top of the Tuning Unit—Figure 2.)

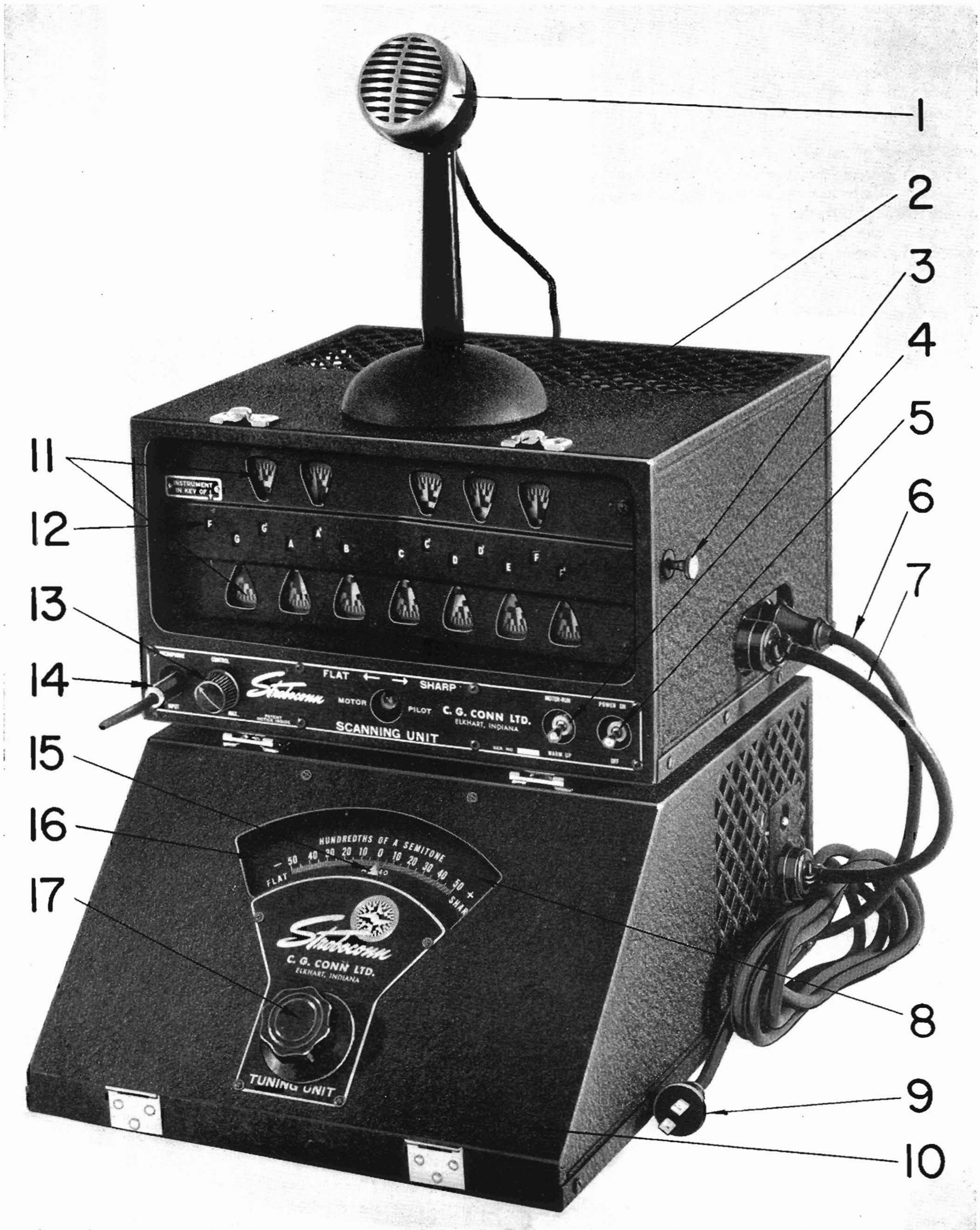


Figure 2—The Complete Stroboconn, Model 6T-3

1. Microphone
2. Scanning Unit
3. Transposing Knob
4. Motor Switch
5. Power Switch
6. AC Power Cable
7. Interconnection Cable
8. Tuning Unit Scale (Sharp Side)
9. AC Connector
10. Tuning Unit
11. Scanning Windows
12. Key Signature Window
13. Volume Control
14. Microphone Connection
15. Tuning Unit Scale Pointer
16. Tuning Scale (Flat Side)
17. Tuning Knob

CAUTION: The Stroboconn is designed to operate on a power source supplying 105-120 volts, 50-60 cycle alternating current. Connection to improper power source may cause damage to the instrument. If operation on direct current is required, a converter must be used.

FOR OPERATION ON LOW LINE VOLTAGE: The 6T-3 Stroboconn is equipped with a line voltage switch to provide normal motor drive power under conditions of low power line voltage. The NORMAL position is recommended for all occasions of use except when the power line voltage is so low that the scanning unit motor will not drive the discs synchronously. This condition will be evidenced by the blinking of the motor pilot light or by oscillation of the observed stroboscopic pattern. CAUTION: Operating the Stroboconn with the switch in the LOW line voltage position on normal line voltage, however, will subject the tubes and electrical components to undue strain, possibly shortening their lives and causing failure of the instrument.

HOW TO START THE STROBOCONN

To turn on, first lift the No. 1 or "Power" switch at the extreme right hand end of the scanning unit to the ON position. No. 2 switch should be pushed down to the WARM-UP position, and about forty seconds allowed for the vacuum tubes to warm up. (This allows the fork to build up its vibration sufficiently to drive the motor, and will be shown by the MOTOR PILOT light in the center of the scanning unit glowing *steadily.*) The No. 2 switch at the right side of the scanning unit should now be lifted to the RUN position. This transfers the power from the motor to the fork drive and turns on the Microphone Amplifier, which takes about twenty seconds to heat up. Sound reaching the microphone should then cause the windows in the mask to be illuminated. If the MOTOR PILOT light does not glow steadily, but blinks after the No. 2 switch has been lifted, the fork has not been allowed sufficient time to build up its vibration, and the No. 2 switch should be pressed down and a little more time allowed.

When the above operations have been performed the Stroboconn is ready for use.

(Refer to Fig. 2 for identification of Parts mentioned.)

READING THE STROBOCONN

With the Stroboconn the frequency of any tone lying within the essential range of the piano keyboard may be determined directly. The method is entirely visual and does not involve the sounding of any comparison tone. Deviations are measured from the tones of the equally tempered scale based on the standard A of 440 cycles per second.

While a high order of accuracy is attained, the process of measurement is simple and rapid and the readings are obtained directly without further computation or reduction.

The appearance of the Stroboconn, as set up for use, is illustrated in Figure 1. Figure 2 also shows the two units, with parts identified, the one above being labeled "Scanning Unit," and the lower being labeled "Tuning Unit." In the Scanning Unit, as is seen in Figure 2, there are twelve windows having the relative positions of the white and black keys of the piano keyboard, in the octave from C to B. The twelve notes of the chromatic octaves are thus represented, the top row of windows corresponding to the black keys, and the bottom row corresponding to the white keys. Sound picked up by the microphone causes these windows to be illuminated.

Each window is in front of a round disc having certain printed patterns—Figure 3. These discs revolve at different speeds, being driven by gears at different ratios, and appear to have seven bands in the printed pattern. A neon tube circles the disc inside the unit, and when a sound is picked up on the microphone it causes the tube to light up or flash according to the number of sound wave vibrations. When these flashes correspond to the same number of black squares turning past the window on a disc, the lighted pattern appears to stand still. This is the same stroboscopic principle with which you are familiar in the movies, where the spokes of a wagon wheel may appear to stand still, or go backwards. If the pattern is turning slightly faster than the light flashes, each spoke or square will appear to be slightly ahead of the last one, giving the optical illusion of a moving pattern turning clockwise. (Fig. 8)

For example, supposing that the scale pointer is set at zero, and that a piano "A" string is sounded tuned to 440 vibrations per second. There will appear across the center of the "A" window a characteristic stationary pattern composed of alternate light and dark bars, having an appearance similar to that shown in Figure 4.

Upon sounding the A an octave higher (A-880), a similar pattern appears in the same window with twice the number of bars, since the frequency is doubled. (Fig. 5) The position of the pattern, however, is shifted outward from the center to the next band in the window pattern (compare Fig 4 and 5). Bands are provided for seven octaves so that any one of the seven A's within the piano range can produce its own appropriate stationary pattern on its appropriate octave band. (Fig 6)

Sounding the seven A♯'s will similarly cause patterns to appear in the A♯ window, and sounding the seven B's will cause patterns to appear on the seven bands of the B window, etc. Since there are twelve windows, there

is space provided for 7 x 12, or 84 notes, essentially covering the range of the piano keyboard. (See Fig. 6). (Procedure for tuning A_0, $A\#_0$, B_0 and C_8 will be explained later.)

The foregoing explanation assumes that the pointer on the tuning unit has been left at zero. With the scale pointer set at zero, the Stroboconn is in exact tune with the equally tempered scale based on A-440 vibrations per second. With the pointer set to any position *other* than zero all notes are equally changed in hundredth parts of semitone; and the Stroboconn *is still in tune with the equally tempered scale* based, in this case, on an A of some other frequency. (Figure 7 shows the vibration frequencies corresponding to different settings of the pointer.)

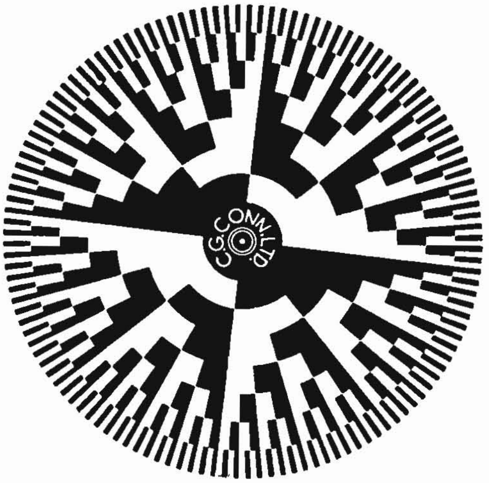


Figure 3—Stroboconn Scanning Disc in Stationary Position.

Now refer to illustration 7. Notice that the tuning scale is calibrated in hundredths of a semitone (referred to hereafter as "cents," that is, 1/100th of a semitone=1 cent, etc.). Four cents deviation from A-440 is equal to approximately 1 vibration per second as indicated by the diagram.[1] Therefore, if it is desired to tune the piano to A-445, move the pointer to the right to plus 20, 5 (vibrations) $\times$ 4 (cents per vibration)=20 cents, or for A-435 move the pointer to left to minus 20, etc. Figure 7 shows how the pointer would be moved to tune any frequency standard. Table No. 1 shows the deviation settings for various pitches.

Under many circumstances it is not sufficient merely to know that a tone is sharp, on pitch, or flat. It is frequently very important to know how much a tone departs from standard tuning. This information can be obtained by simply turning the scale pointer until the pattern stops.

Take, for example, an A which has been tuned flatter than standard, say to 435 vibrations per second instead of 440. In the "A" window the pattern will be seen apparently moving toward the left. (Fig. 8.) Now by moving the scale pointer in the same direction, to the left, the pattern may be brought to a standstill.

The pointer will then read "—20" on the graduated scale above the adjusting knob, thus showing directly how much the 435-vibration tone is flat compared to the standard A of 440—the reading being expressed in hundredths of a semitone (cents). If the entire piano has been tuned to equal temperament (without stretch) on this lower pitch standard, then all strings would produce stationary patterns with the pointer at "—20."

Obviously, any frequency in the range concerned will always be within 50 hundredths of a semitone from some note of the standard scale. (Table 1.) To learn how much is its deviation, it is only necessary to turn the knob to the right or to the left until the appropriate pattern stands still. The only judgment lies in deciding when the pattern is stationary. No comparison tone is ever sounded and all counting of beats or estimation of drift speed is eliminated. Furthermore, deviations can be read directly from a single graduated scale which serves for all tones.

While the scale on the Tuning Unit is graduated only to 50 hundredths of a semitone, plus or minus, measurement of deviations of more than 50 hundredths of a semitone from a particular note can readily be made by

[1] The publication "A Table Relating Frequency to Cents," by Young, is available from C. G. Conn Ltd. Price $1.00

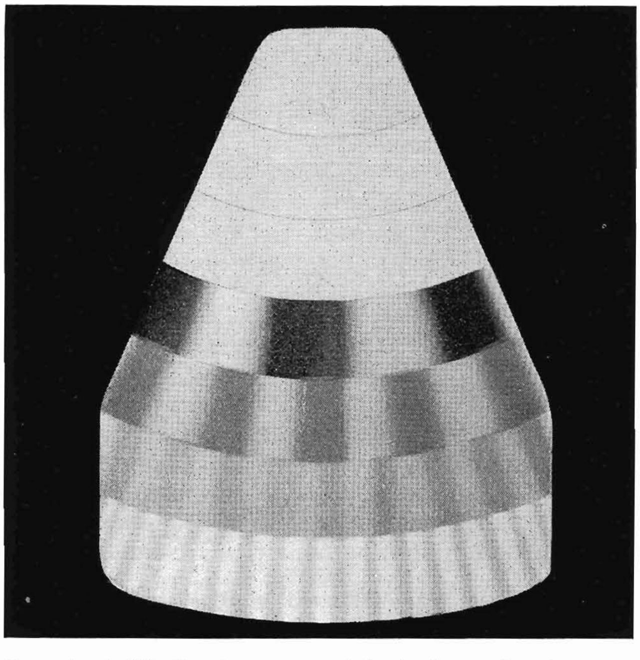


Figure 4—A-440. Showing pattern of the fundamental as it appears in 4th Octave Band of the "A" window.

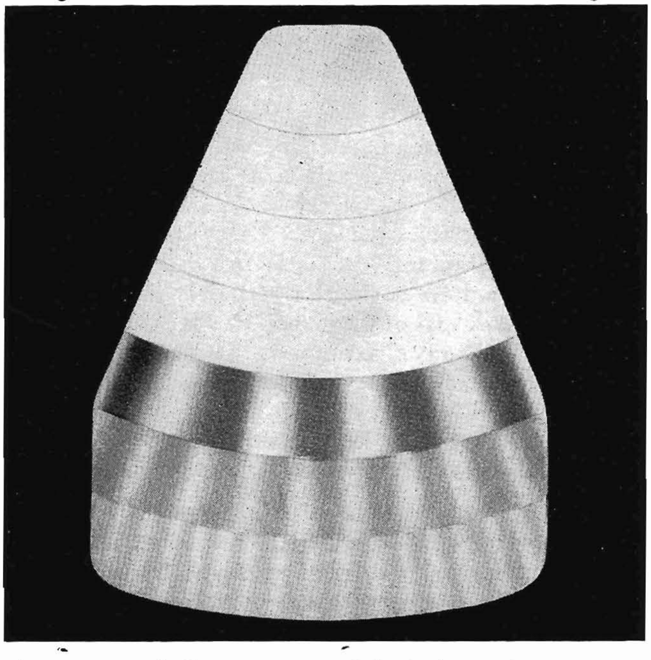


Figure 5—A-880. Showing pattern of the fundamental as it appears in 5th Octave Band of the "A" window.

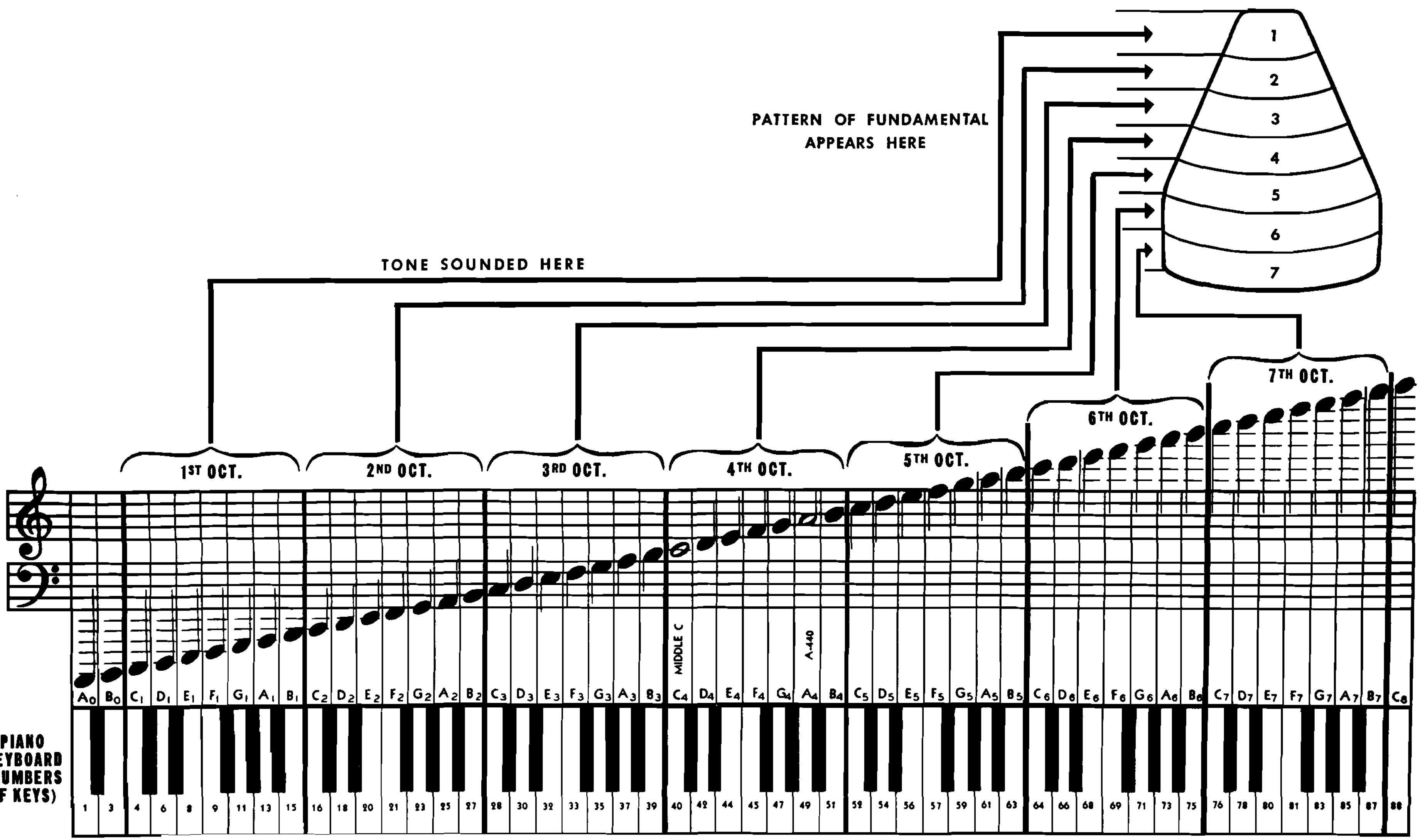


Figure 6—Shown here is a drawing of a piano keyboard, with the seven octaves separated*. Lines connect the octaves with the corresponding octave band in the Stroboconn window. For example, when any tone in the first octave is sounded, look for the pattern in the first octave band. Any tone in the second octave will be shown in the second octave band, and so on, through the third, fourth, fifth, sixth and seventh octaves. NOTE: See text for special instructions in tuning C_8 and all tones below C_4.

***For the purpose of this manual, the octaves of the piano have been divided as follows: First octave includes C_1 through B_1; second octave C_2 through B_2, etc., through third, fourth, fifth, sixth and seventh octaves.**

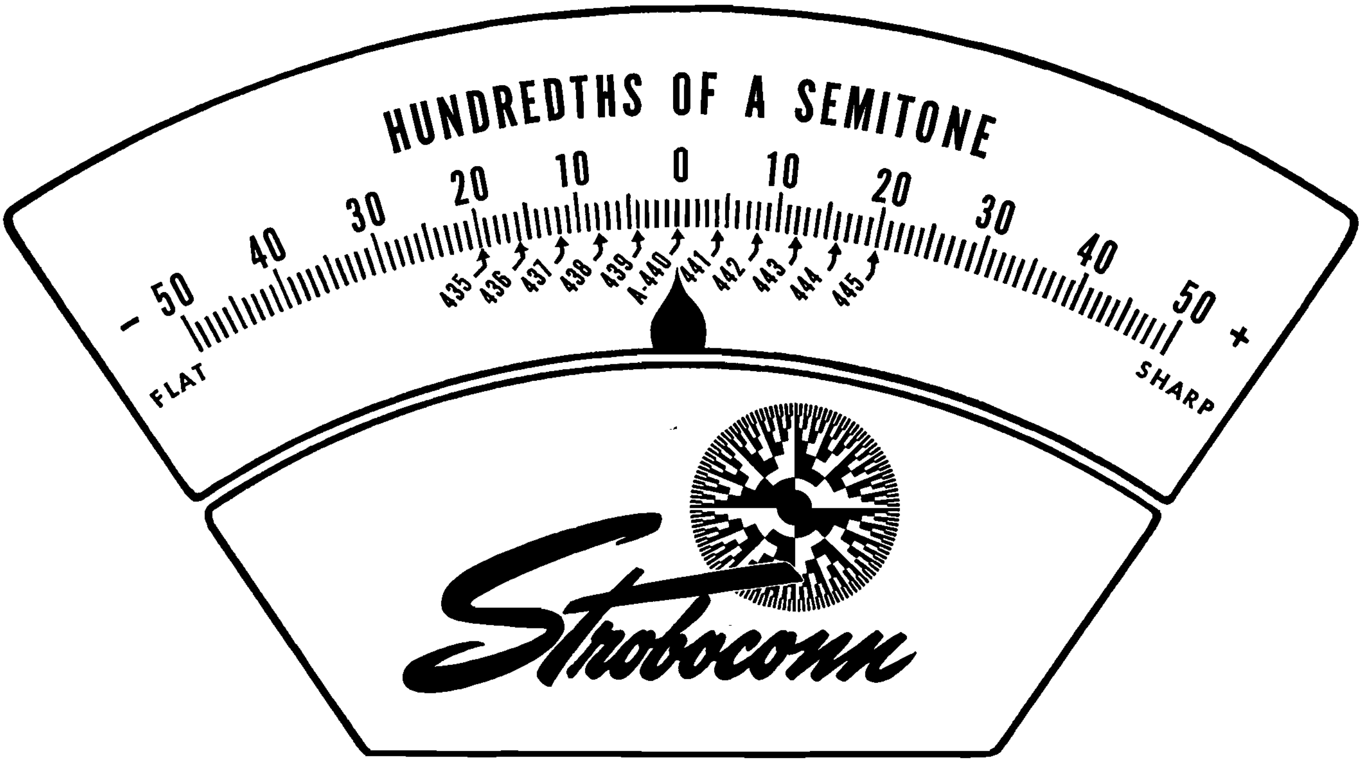


Figure 7—Close-up of Tuning Scale, with pointer set at zero, or A-440. Small numbers indicate where pointer would be set, at single vibration intervals, to tune to an "A" of any desired frequency (See Table 1).

	Cents From A	Cents From Bb	Frequency Cycles/Sec.
		+50	479.82
		45	478.44
		40	477.06
		35	475.68
		30	474.31
		25	472.94
		20	471.58
		15	470.22
		10	468.86
		5	467.51
Bb	+100	0	466.16
		− 5	464.82
		−10	463.48
		−15	462.14
		−20	460.81
		−25	459.48
		−30	458.16
		−35	456.83
		−40	455.52
		−45	454.20
	+ 50	−50	452.89
	45		451.59
	40		450.28
	35		448.99
	30		447.69
	25		446.40
	20		445.11
	15		443.83
	10		442.55
	5		441.27
A	0	−100	440.00
	− 5		438.73
	−10		437.47
	−15		436.20
	−20		434.95
	−25		433.69
	−30		432.44
	−35		431.19
	−40		429.95
	−45		428.71
	−50		427.47

Table 1

	Cycles /Sec.	Cents
	445	+20
	444	+16
	443	+12
	442	+ 8
	441	+ 4
A	440	0
	439	− 4
	438	− 8
	437	−12
	436	−16
	435	−20

Table 1-A

Tables 1 and 1-A—Showing Scale Pointer settings for deviations from standard Bb and A.

reading in a neighboring window. For example, a high pitch A of 457 cycles per second, which is 66 hundredths of a semitone sharp, is read in the A♯ window, the reading being 34 hundredths of a semitone flat from A♯.

To aid players who play musical instruments built in keys other than C and who have not learned to transpose mentally, a transposition indicator is provided, (See Fig. 2), operated by a knob at the top of the Scanning Unit. An opening at the left hand end of the mask under "Instrument In Key Of" shows key of the instrument, and the labels opposite each of the twelve windows always correspond with the written notes for that instrument. For example, if an Eb instrument is to be used, the pulling of the knob will change the label at the Eb window to C, this being the written note that must be played in order to produce a stationary pattern in the Eb window. At the same time the labels at each of the other windows will similarly be changed to correspond with the written notes for an Eb instrument. Provision is made for transposition into all the commonly used keys: C, Db, Eb, F and Bb.

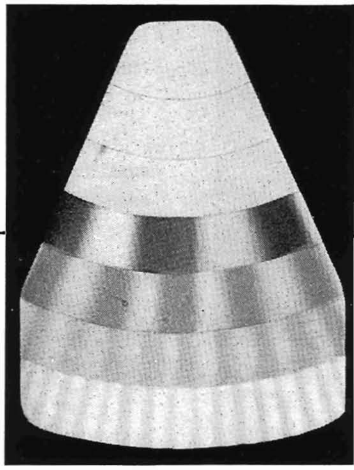


Figure 8—Interpreting Pattern movement.

TUNING THE PIANO

Since the use of the Stroboconn in piano tuning has become relatively widespread, we have found a marked degree of similarity in the procedure followed by various tuners who are using it. After consulting with numerous tuners, we find the following procedure more or less typical:

PLACING THE STROBOCONN IN POSITION. For best and most rapid results, the Stroboconn should be placed on a table, chair or stand, in a position where it can be most easily read while the piano is being tuned.

LOCATING THE MICROPHONE. Both the airborne and contact microphones are available with the Stroboconn. The airborne mike is supplied with the outfit and the contact mike can be ordered as extra equipment. Best results are obtained when the microphone is located as close as possible to the string being tuned. Most tuners place the airborne mike above the keyboard of the piano, and shift it from time to time as they proceed up and down the scale. The contact microphone is clipped to some part of the piano which is found to be carrying the string vibrations. (Experimentation may be necessary.)

The contact mike has an additional advantage, particularly when it is necessary to tune the piano where there are interfering noises. The contact mike will pick up only the vibrations of the piano strings and other interfering noises will be somewhat suppressed. It has also been found that the comparative advantages of the two microphones differ with the individual piano.

TUNING PROCEDURE. After the piano is prepared for tuning with the Stroboconn and its microphone in position, set the Stroboconn pointer at the proper setting for the standard to which the piano is to be tuned. If the piano is to be tuned to the Standard Tuning frequency of A-440, set the pointer at zero. If it is to be tuned to some other standard, find the proper setting in

Figure 9—Stroboconn mounted on portable table which many tuners prefer.

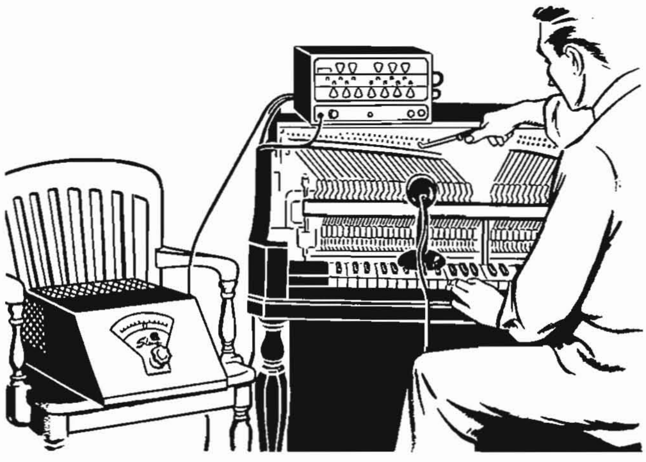


Figure 10—Stroboconn can be placed on any convenient chair, on a piano bench, or on top of piano itself. Several other setups can be used, depending on desires and facilities of the individual tuner.

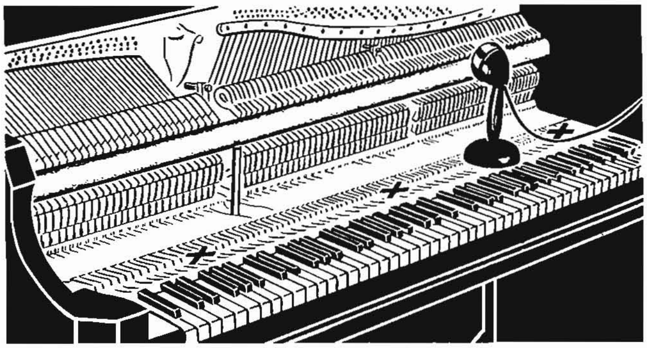


Figure 11—Air-borne microphone located on piano keyboard. It may be necessary to move mike several times in order to obtain maximum reception on the string being tuned.

Table 1-A or Figure 7. For example, for A-435, set pointer at minus 20 and for A-442 set pointer at plus 8.

Many technicians prefer to start tuning at the "break" in the scale because of the marked change in the inharmoncity of the partials of the tones at this point. The stiffness of piano strings causes the tones produced to have partials that are not harmonically related to each other; that is, the second partial is not exactly twice the frequency of the first partial, or fundamental, of the tone. The third partial is not three times the frequency of the fundamental, and so on. For partials to be harmonic they need to bear a whole number relationship (1, 2, 3, 4,----) to the fundamental. The partials in piano tones are always slightly higher (sharp) than the whole number multiples (harmonics) of the fundamental. This has a very important bearing upon the tuning of a piano.

When listening to two piano tones an exact octave apart, the second partial of the lower tone will be sharp with respect to the fundamental of the higher tone. This will cause audible beats to be produced and the listener will not consider the tones to be truly an octave apart even though the fundamental frequency of the top tone is exactly twice the fundamental frequency of the lower tone, as is required for a true octave. In order for the octave on the piano to sound in tune when the two notes are played at the same time, it is necessary to stretch the interval by lowering the bottom tone or raising the top tone. The technique for determining the optimum amount of stretch with the Stroboconn will be explained as we go along.

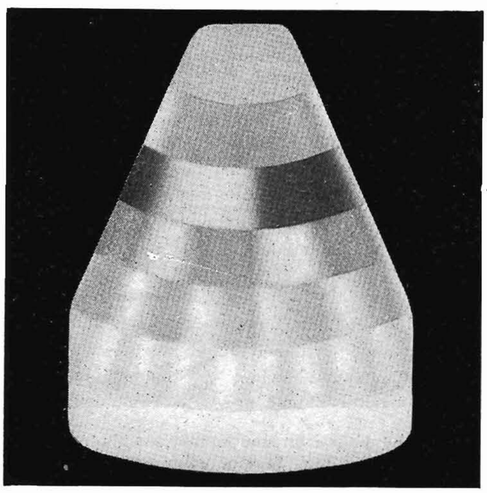
The inharmonicity of piano tone partials is usually smallest in the middle of the keyboard so an octave is chosen there for setting the temperament. Care should be taken that the "break", or a marked change in string design, does not occur within the temperament octave.

All but one string per key is muted with felt or wedges so only one string at a time sounds when a key is struck.

Let us assume that C_4 (middle C) is chosen for the starting point as an example. Some other starting point might be preferred and could be used as well. Proceed from C_4 up the scale, tuning one string on each key while watching the fourth ring, or pattern band, in the appropriate windows. The Stroboconn pointer is left in the position chosen to establish the tuning standard while tuning this octave.

It may be noted while tuning this octave that even though the tension on the string is adjusted to cause the fourth ring pattern to be stopped, the patterns in the fifth and higher rings will move slowly to the right due to the fact that the partials producing those patterns are not exactly in a 2, 4, 8----- relationship to be fundamental of the tone. If the fifth ring pattern moves to the right for the C_4 string, when the fourth ring pattern is not moving, the tuner can note how far to the right he needs to move the Stroboconn pointer in order to make the fifth ring pattern stand still. If this is one cent or more, it indicates that C_5 should be tuned sharp by at least that amount. Therefore, when tuning C_5 the pointer is advanced to the right of the starting position used for tuning the temperament octave. This is the beginning of the octave-stretching process.

The fundamental is usually the strongest partial in the tones above C_4, and the higher partials are progressively weaker. Thus, the fundamental and the second partial are the two most important parts of the tone to consider when tuning octaves. However, the meticulous



To "stretch" the first octave, read the pattern made by the overtones in the 3rd octave band.

To "stretch" the 2nd or 3rd octave, read the pattern made by the overtones in the 4th octave band.

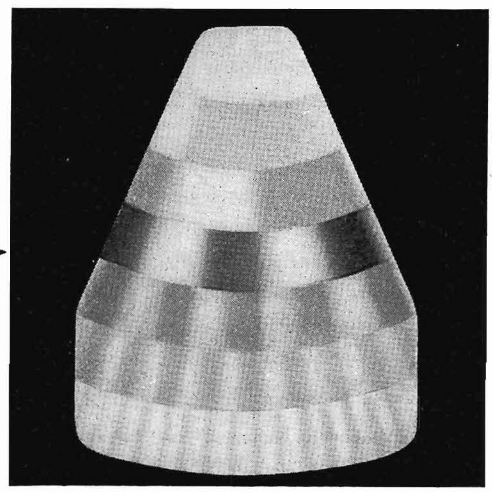
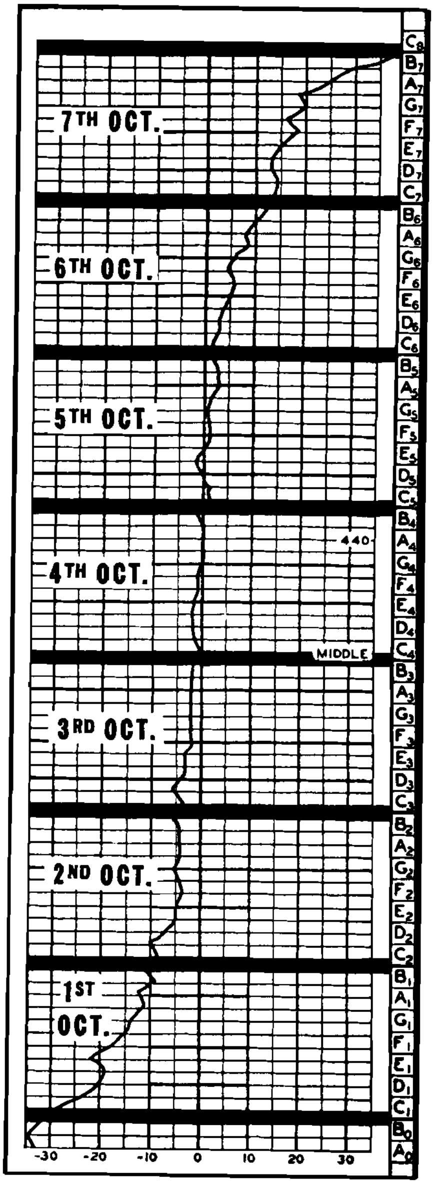


Figure 13—"Stretching" First Octave.

Figure 14—"Stretching" 2nd and 3rd octaves.



[1]**Figure 15—Average of 16 pianos tested by Railsback show that piano tuners usually tune progressively sharp in the middle and high octaves and progressively flat in the low. This graph is intended to show only the trend which seems to be followed by most tuners. It is not to be taken as a pattern to be followed and is not to be considered as a recommended model of a perfect tuning job.**

MISCELLANY

1. **Lower Octave Patterns.** It has previously been explained that in the lower three octaves of the piano the fundamental tones are notoriously weak with their strong overtones. These weak fundamentals produce a rather vague pattern, of short duration, in the Stroboconn windows. At the same time, the overtones also produce their patterns in the various octave bands of the appropriate windows. As a result, a tuner using the Stroboconn for the first time may be somewhat confused by the great number of flashing patterns which appear when the lower octaves are tuned.

Because of the characteristics of the strings themselves, the patterns in the lower octaves will never be quite so clear and distinct as those made by the strings in the middle and upper octaves. However, as greater familiarity with the instrument is obtained, as a result of practice, the tuner will recognize that even though these patterns are vague, they are clear enough, and of sufficient duration to make an accurate reading possible. It is therefore advisable, because of the short duration of the patterns, to strike the strings more frequently while tuning the lower octaves so that the pattern will be reproduced sufficiently to obtain the reading.

Also, since it may be desirable to stretch the lower octaves on most pianos, the readings will be taken from the third and fourth octave bands, and there will be very few occasions to obtain the readings directly from the first and second octave bands.

2. **"Stretched Octave" Tuning.** It is common knowledge that there has been considerable controversy and discussion over "Stretched Octave" tuning. It is not the purpose of this booklet to establish a pattern to follow, or to advise the tuner how he should tune the octaves with relation to each other. Whether or not the upper octaves *should* be tuned progressively sharp as the scale is ascended, and progressively flat as the scale is descended, is a matter of personal and individual taste. It is intended to emphasize, however, that by using the Stroboconn, the octaves may either be stretched, tuned to the equally tempered scale, or tuned to any variations from standard, as might be desired by the tuner or customer.

3. **Setting the Temperament.** Before the commercial availability of the Stroboconn, tuner and technician were entirely dependent upon the ear to tune the customary temperament octave. Although the quality of the work done by the skilled and experienced tuner reaches a high degree of excellence, it still requires a considerable length of time to set an acceptable temperament in this manner. Skilled piano tuners now find the Stroboconn an invaluable aid which enables them to tune the temperament octave to an accuracy of one one-hundredth of a semitone, in as little time as it requires to tune any other octave. Equal temperament is accurately established visually; however the amount of "stretching" required is best determined visually and aurally.

4. **Microphone.** Two microphones are available for use with the Stroboconn. The airborne microphone is included with the Stroboconn as part of its standard equipment, and the contact microphone is available as an extra accessory.

It cannot be stated definitely that either microphone will give results superior to the other, in all cases. The airborne microphone has been found to be satisfactory in most cases, but on some pianos the contact microphone seems to do a better job in the extreme upper and lower octaves. It is true, however, that in all cases where the tuning must be done in the presence of outside and extraneous noises, the contact microphone will help.

5. **Filter.** Several years ago experiments were conducted to develop a low-pass filter to be used with the Stroboconn microphone. This filter was designed for use under circumstances where it might be desirable to point up the fundamental patterns by eliminating the overtones. Since it is necessary to tune to these overtones when stretching octaves, it is therefore not desirable to eliminate them; so that the USE OF THE FILTER FOR PIANO TUNING IS NOT RECOMMENDED, and is not available.

[1] O. L. Railsback, J. Acous. Soc. Am. 9:274 (1938); 10:86 (1938).